Microphones

Microphone

Microphone (Mic): is a transducer that converts acoustical sound energy into electrical energy. Its basic function is therefore to convert sound energy into electrical audio signals which can be used for further processing.

- Sound in electrical form can be amplified, mixed and recorded.

- We can convert the acoustical waveform into an electrical waveform of the same shape.

- Amplitude becomes voltage (V), and air particle motion becomes electrical current (I) - electrons playing the role of air particles.
- The current's direction of flow changes with cycles of compression/rarefaction creating an alternating current (AC)

Basic Microphone Types

- Dynamic (moving coil)
- Condenser (capacitor)
- Electret
- Ribbon
- Piezoelectric (crystal or ceramic)

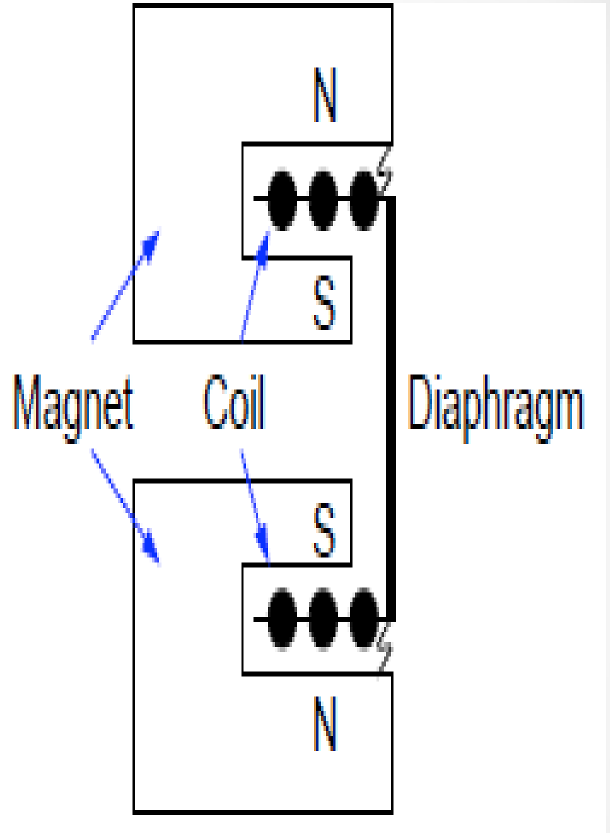
Dynamic (moving-coil)

Ribbon

Condenser

Dynamic microphones

- Dynamic mics consist of a diaphragm suspended in front of a magnet to which a coil of wire is attached.
- The coil sits in the gaps of the magnet.
- Vibrations of the diaphragm make the coil move in the gap causing an AC to flow.
- Coils of wire are used to increase the magnitude of the induced voltage and current



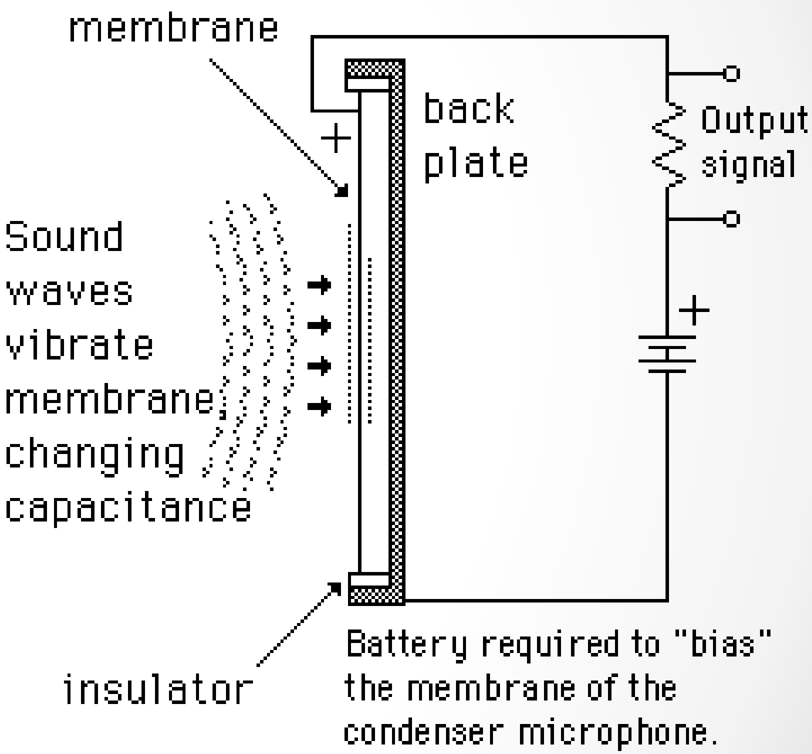
Dynamic microphones

- Diaphragm and coil must be light
- Low output impedance – good with long cables
- Rugged

- It provides excellent fidelity, extremely stable performance characteristics and a high degree of ruggedness - all at a reasonable price. These same characteristics are ideal for conventional sound reinforcement and recording as well.
- the dynamic microphone is a good choice for most applications.

Condenser Microphone

- Condenser Microphone called as Capacitor Microphone or Electrostatic Microphone also, is made up of two parallel very thin plates, positively and negatively charged respectively.
- **These 2 plates act as electrodes and are kept at opposite polarities by supplying D C to behave as a condenser, they should be insulated from each other.**
- **It has a very thin diaphragm of thickness 1 to 10 micrometers.**



Condenser Microphone

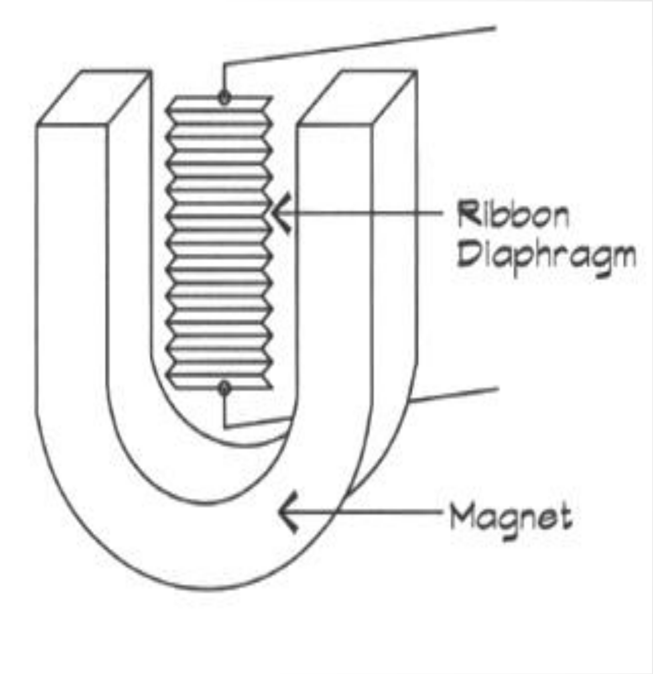
- When sound wave pushes the diaphragm, it vibrates and the capacitance of the condenser (or capacitor) changes.
- This is because the capacitance is proportional to the potential difference and inversely proportional to the separation between the plates.
- In condenser mics, the front plate is the diaphragm which vibrates with the sound. The charge (Q) is fixed, thus changes in the distance d between plates result on changes of voltage (V)
- Any change in the separation changes the capacitance and leads to voltage change. The voltage is fed to an amplifier to amplify the level of the signal.

Condenser Microphone

- The diaphragm can be very light, rendering a flat frequency response (with a small resonance peak at above 12kHz).
- Output impedance of condenser mics is much higher than for dynamic mics.
- High output makes it more robust to noise.
- Condenser microphones, many of which are capable of very wide frequency response, have been widely used in recording studios for years.

Ribbon Microphone

- A Ribbon microphone uses a corrugated ribbon made of a metal is suspended in a magnetic field.
- Sound causes the ribbon to vibrate. This means change in magnetic flux through the ribbon. This induces an electric current.
- Its electrical output is very small and needs to be stepped up by a transformer.
- The lightness of the ribbon guarantees a flat frequency response for mid and high frequencies up to 14kHz.

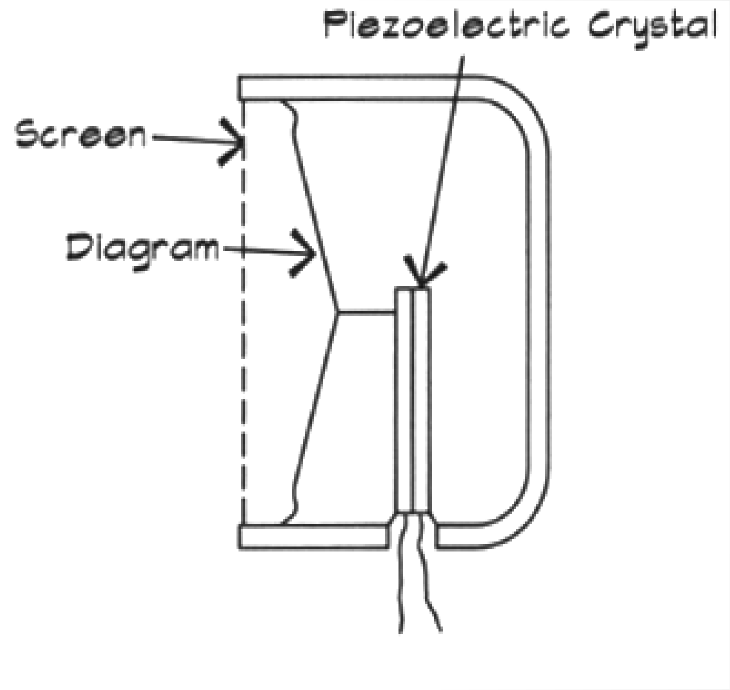


Ribbon Microphone

- The ribbon microphone senses pressure gradient and not just pressure. Therefore, it detects sound from both sides.
- They are more expensive that many moving-coil mics and have to be handled with care, particularly when it comes to loud sound levels.
- This means a poorer signal-to-noise ratio if the mic is too far from the sound source or if the cable run is too long.

Piezo-Electric Microphone

- **Diaphragm mechanically coupled to a piezoelectric material Piezo generates electricity when strained.**
  - **No polarization voltage**
  - **Generally rugged**



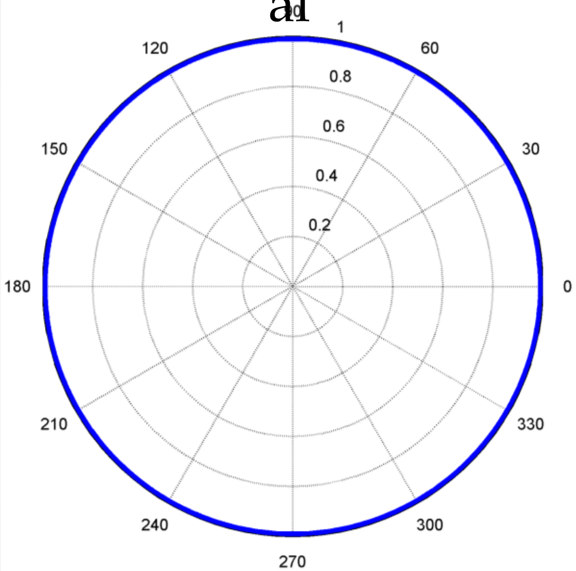
Microphone Directivity PatternS

- **Single-diaphragm microphones are typically constructed to have one of a variety of directivity patterns**
  - **Omni directional**
  - **Bidirectional**
  - **Cardioid**
  - **Hypercardioid**
  - **Supercardioid**

- Microphone Pickup Patterns - A microphone's pickup pattern is three dimensional in character and shows how the microphone responds to sound from different locations. Omnidirectional microphones pick up sound from all directions. Unidirectional microphone reject or reduce sound from their sides or rear.

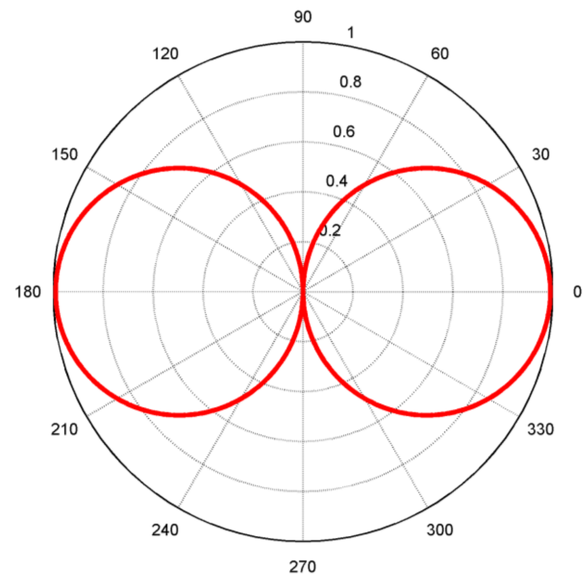
Directivity Patterns

Omnidirectional



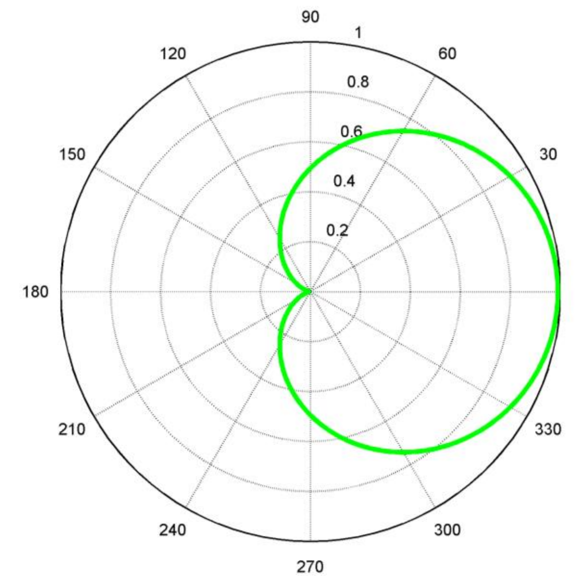
$$P = 1$$

Bidirectional



$$P = \cos\theta$$

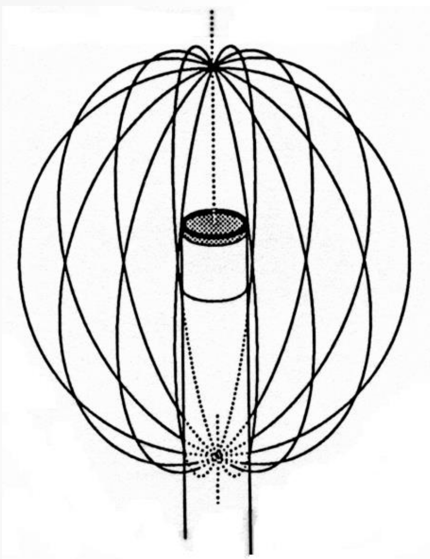
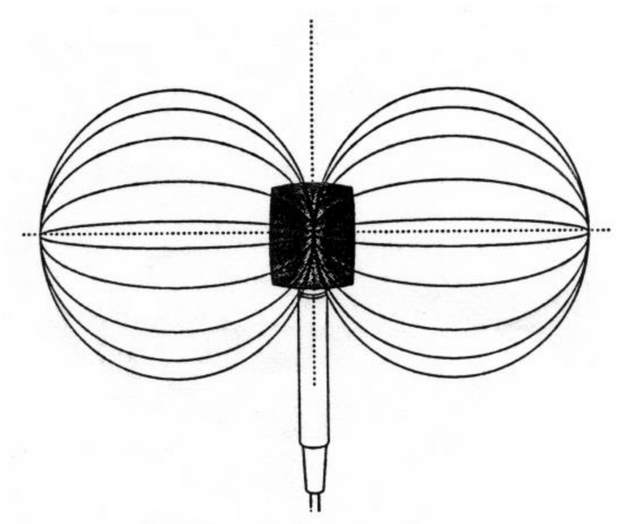
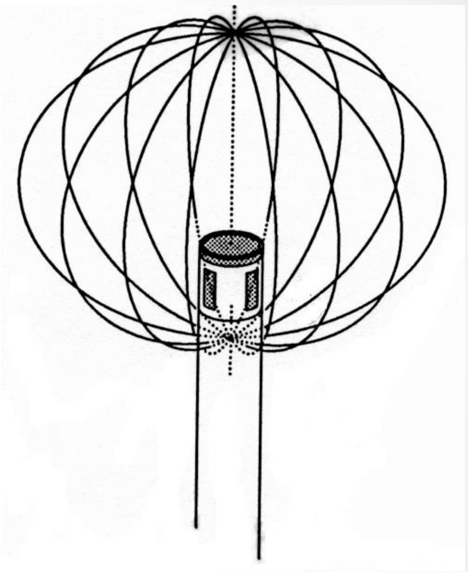
Cardioid



$$P = \frac{1+\cos\theta}{2}$$

- **Sensitivity is usually given in terms of a reference SPL, e.g. 94 dB or 1 Pascal (Pa).**
- **Condenser microphones (5-15 mV/Pa) are more sensitive than moving coils (1.5-3 mV/Pa) and ribbons (1-2 mV/Pa)**
- **More amplification is needed for moving-coils and ribbons (which are thus more susceptible to interference). Also, low-sensitivity mics need high-quality (low noise) amps and mixers.**

Directivity in 3D

Omnidirectional	Bidirectional	Cardioid
		
$P = 1$	$P = \cos\theta$	$P = \dfrac{1 + \cos\theta}{2}$